Visualization and Decision Support Tool R&D – PNNL Experience

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Key Challenge: Data to Information

The major challenge is in translating new real-time data into actionable knowledge that enables operation of the system in ways never before possible – *ensuring unprecedented Reliability, Resilience and Efficiency.*

We need:

▶ New networks to route data securely and efficiently

▶ Distributed signal analysis and hardware automation

▶ New analytic methods to extract new information

▶ Simulations that run in microseconds vs. minutes, minutes vs. days

▶ Visual analytics to aid decision making

▶ Counter measures to advanced, persistent threats

Electricity Infrastructure Operations Center
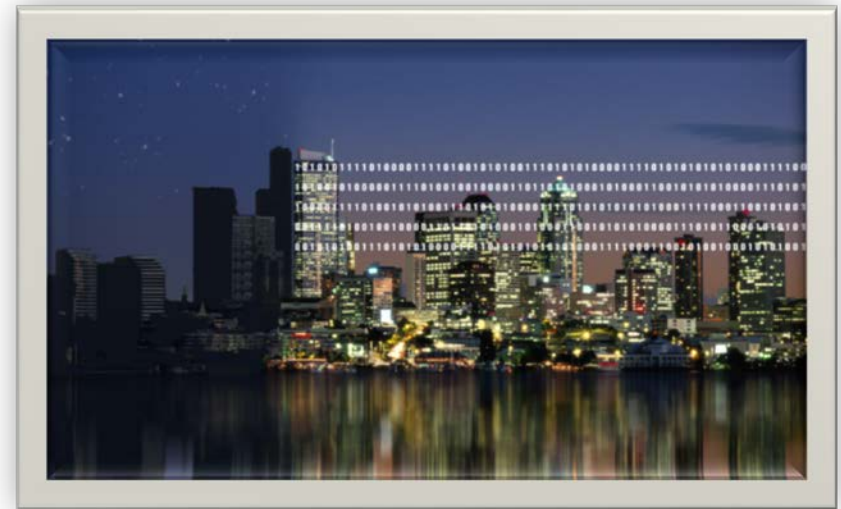
Unique national asset to research, develop & test next generation tools and concepts for operating the electric energy infrastructure

- ► Laboratory supporting power systems research for a variety of electric grid issues

- ► Live data resources from actual grid operations nationwide

- ► Supporting data network, data archival and HPC capabilities

- ► Linked to the national visual analytics center (NVAC)

- ► State-of-the-art grid operation & modeling tools (Alstom Grid, GE Ventyx, Siemens)

- ► Fully capable grid control center for training and backup

Graphical Contingency Analysis

- ▶ Converts large amounts of data into easy-to-interpret visualization of grid power flow
- ▶ Identifies and prioritizes areas of concern; recommends corrective actions
- ▶ Evaluated by WECC operators, indicating 30% improvement in response to emergencies
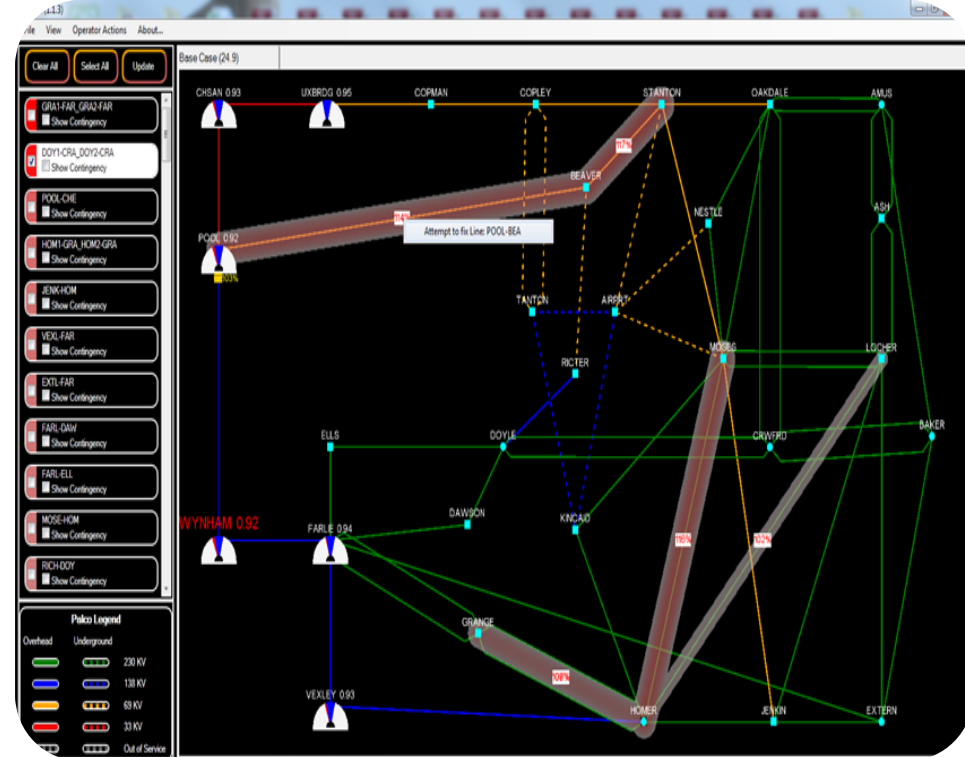
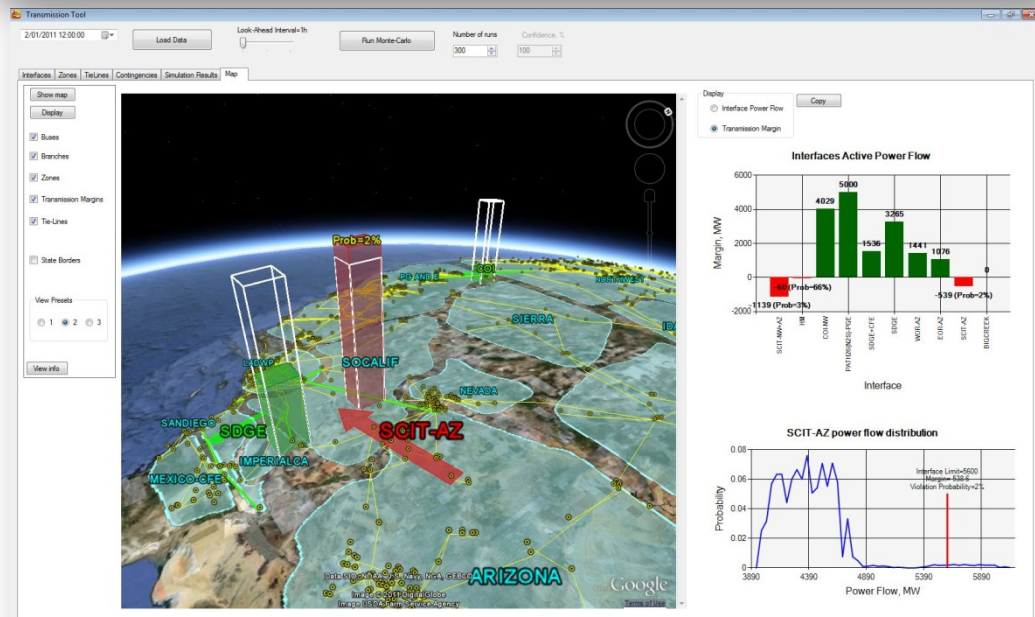**The Graphical Contingency Analysis tool depicts areas of concern in red.**

Probabilistic Approach for Ramping and Transmission Capacity Adequacy

Probabilistic Ramp Capacity (magnitude, duration, rate) Requirements and Availability
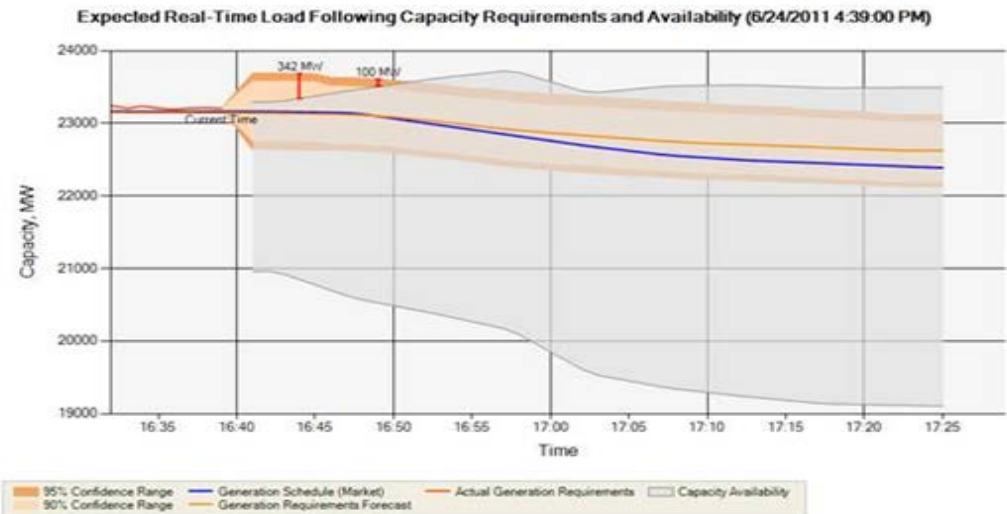
Probabilistic Transmission Requirements and Availability

The tool has been installed and evaluated at CAISO.
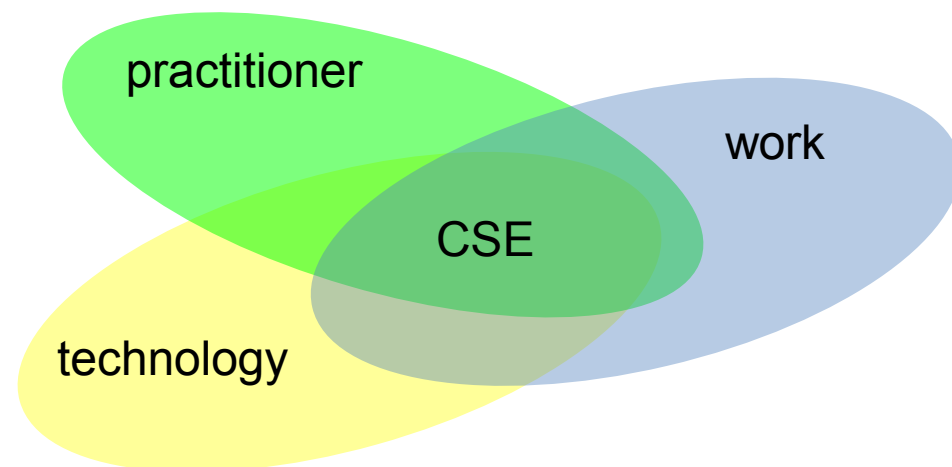
▶ Interdisciplinary approach to the development of

- Principles
- Methods
- Tools
- Techniques

▶ Concerned with cognitive functions of human performance

- Problem solving
- Judgment
- Decision making
- Attention
- Perception
- Memory

▶ Draws on disciplines of

- Cognitive psychology
- Cognitive science
- Computer science
- Human-computer interaction
- Human factors

practitioner

work

CSE

technology

▶ Practice-centered design is driven by understanding:

- The range of tasks the operators perform

- The strategies they currently use to perform those tasks

- The contributors to task complexity

- What new tools and visualizations will facilitate their work

▶ Effective visualizations

- Are based on this understanding

- Aid practitioners as they accomplish work efficiently and effectively

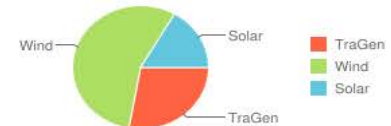- Support human problem solving and decision making

Recent Projects Engaging Grid Operators

▶ BPA wind integration
- Designing cognitive tools to aid real-time operators

▶ NASPI visualization workshop
- Real-time operators providing feedback on vendor's solutions (using synchrophasor data) to simulated grid events

▶ On-going research projects,
- Developing taxonomies for decision making and problem solving of real-time power grid operators
- Investigating intra- and inter-organizational operator communication, coordination and collaboration
- Designing decision-support tools that aid operators in putting data/information into context
- Creating visualizations, based on research findings that are tailored to real-time operators specific work demands, leveraging the powerful perception-action skills of human, while taking advantage of powerful interface technologies

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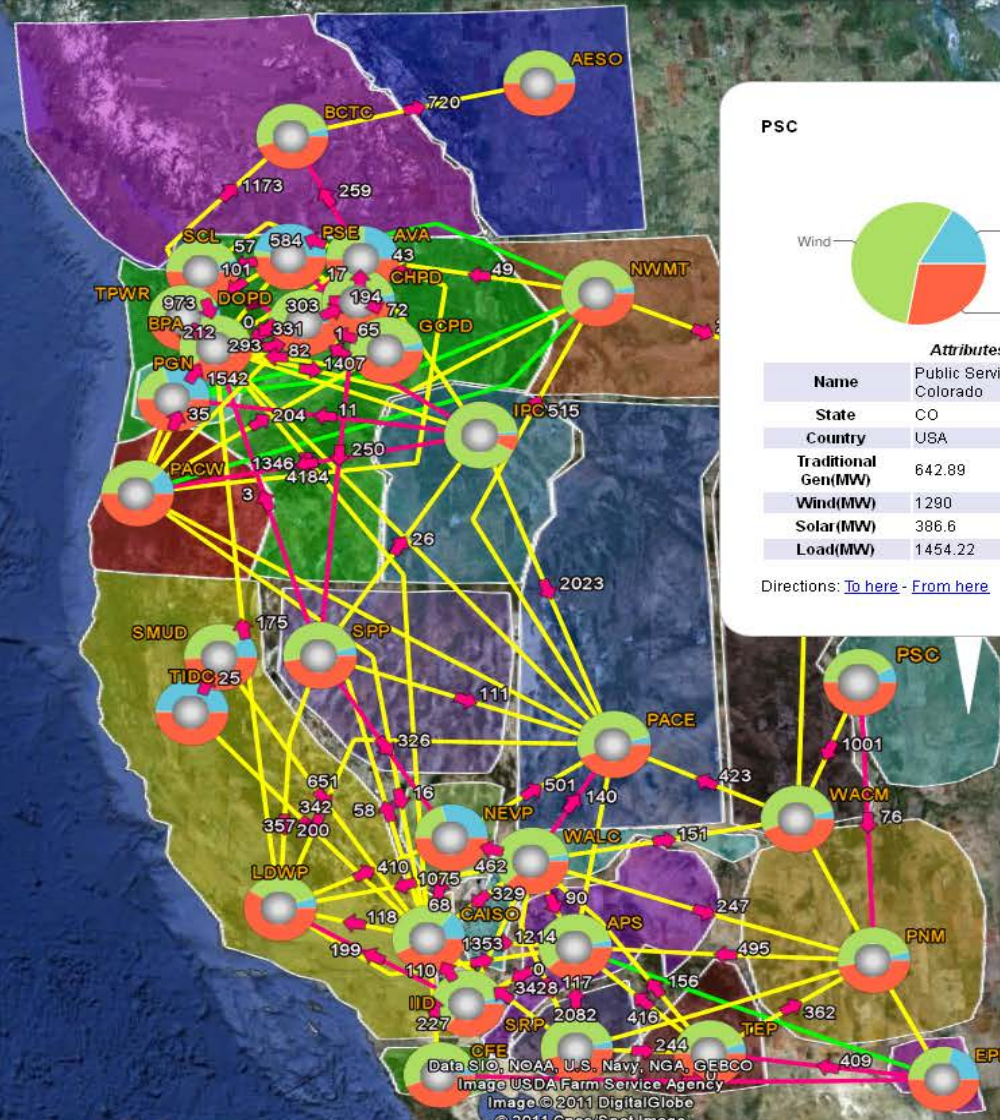# Backup Slides

A Tool Developed for Results Visualization

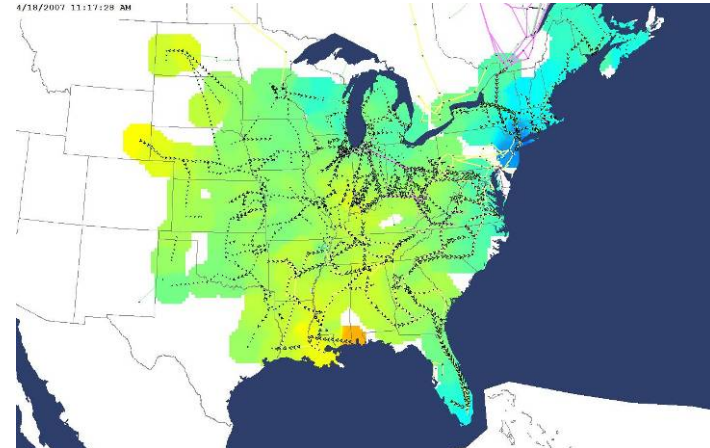# Advanced Visualization and Decision Support Tools R&D
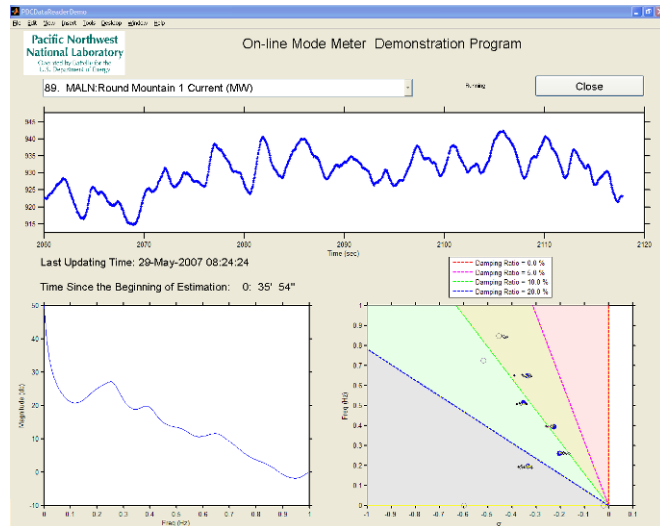
Small Signal Analysis Tool

Wide Area Hybrid Grid Health Tool
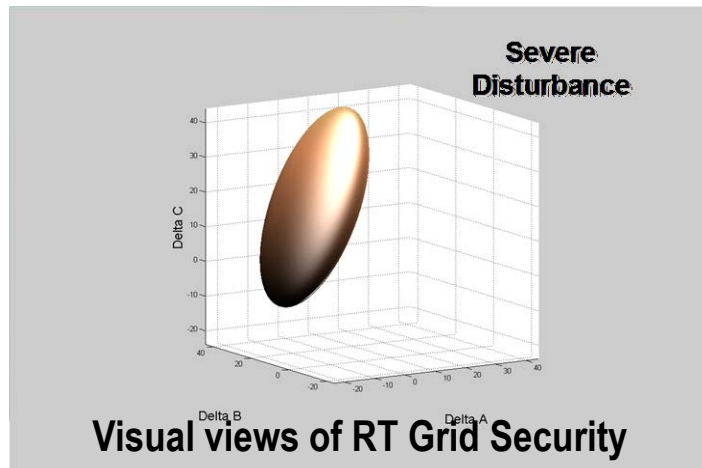
Visual views of RT Grid Security

NVAC Power System View